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MICROMEDIA

CALIBRATION OF THE BAHCO MICRO PARTICLE CLASSIFIER USING BARITE AND SILICA FLOUR

by

P.R.A. Andrews* and R.D. Joe**

SUMMARY

Samples of -50 µm barite and -50 µm silica flour were classified using the Bahco micro particle classifier. Each mineral was separated into eight size fractions, the range of size being between 1.4 µm to 23.1 µm for barite and between 1.5 µm to 34.1 µm for silica flour. The size of each fraction was determined by using a sedigraph and the individual sizes are in approximate agreement with theoretically calculated sizes based on Stokes' Law.

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ÉTALONNAGE DE LA BARYTINE ET DE LA FARINE SILICEUSE À L'AIDE DU CLASSIFICATEUR DE MICROPARTICULES BAHCO

par

P.R.A. Andrews* et R.D. Joe**

RÉSUMÉ

On a fait des études de classement avec des échantillons de -50 µm de barytine et -50 µm de farine siliceuse à l'aide d'un classificateur de microparticules Bahco. Chaque échantillon de minéral a été séparé en huit fractions granulométriques dont la gamme des dimensions se situait entre 1,4 µm et 23,1 µm pour la barytine et entre 1,5 µm et 34,1 µm pour la farine siliceuse. La granulométrie de chaque fraction a été déterminée à l'aide d'un analyseur "sedigraph" et les dimensions individuelles sont en conformité approchée aux dimensions calculées théoriquement d'après la règle de Stokes.

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INTRODUCTION

The Bahco micro-particle classifier, originally developed in Sweden by AB Bahco, has been manufactured in the United States since 1950 by Harry W. Dietert Co. Ltd., Detroit, Michigan. The instrument was purchased in February 1985 as part of the Non-Metallic Mineral Section's program of fine particle classification in the -10 µm range.

DESCRIPTION

The classifier (see Fig. 1) is basically a combination air centrifuge-elutriator consisting of a brush feed system and a rotor assembly driven by a 1 HP, totally enclosed, 220 volt, 3 phase motor. The rotor and motor are enclosed in a cast aluminum housing. The motor operates at 3500 rpm creating precisely controlled air velocities within the air spiral and sifting chamber of the centrifuge.

The feed mechanism consists of a feed hopper with an adjustable outlet and a clear plastic screw cover. Located at the base of the feed hopper are a motor driven brush and a spring plate for dispersion of the sample, a feed nozzle, and a vibrator to control the rate of feed from the nozzle[1].The entire feed mechanism is attached to the lid of the classifier, which when swung back reveals the top of the rotor assembly.

The rotor assembly includes a fan wheel, a sifting chamber with a detachable catch basin, and a series of spaced discs. The whole rotor assembly is held in position by a rotor locking ring located on top of the rotor assembly.

A series of horseshoe-shaped spacers varying in thickness from 4 mm to 18 mm are used to change the velocity of air entering into the classifier. These are held in position by a throttle nut located on the central rotating shaft below the rotor assembly casting.

An auxiliary item is a system for feeding nitrogen into the classifier. This is used only in situations where a static charge may prevent the flow of sample into the classifier.

PRINCIPLE OF OPERATION

The rotation of the rotor assembly creates a spiral of air moving towards the centre. The feed mechanism introduces the sample into this air spiral where it is acted upon by centrifugal forces, the coarser and heavier particles being carried toward the outer periphery of the whirl and the finer and lighter ones being carried toward the centre with the air flow. The size, form and weight of the particles determine the direction they will take in the air current[1].

By the use of different throttle spacers, (No.'s 18,17,16,14,12,8,4, 0; the significance of the spacer number being the thickness of each spacer in mm), a series of graded fractions will be obtained varying in size from ≈30 µm to ≈1 µm depending on the specific gravity of the classified material. The classification is accomplished by either restricting or opening the air feed inlet. In the zero position the throttle nut is at the lowest position which corresponds to the widest opening. Conversely using spacer No. 18, the feed inlet is at the narrowest position. By opening or closing the feed inlet gap the particle terminal velocity is altered. The effective separating particle size is also altered, since the terminal velocity and particle diameter are related by Stokes' Law.

OPERATING PROCEDURE

A predetermined weight of dried sample, which should not exceed 20 g, is added to the feed hopper. The outlet opening is set at the minimum gap position and the plastic screw cover secured.

The largest spacer (Spacer No. 18) is placed in position on the central rotating shaft and secured in place by the throttle nut screw. This operation is best accomplished by holding the spacer and turning the throttle nut screw to hand tightness. The spacer is further tightened by then turning the rotor casing, while holding the throttle spacer.

All rotating parts including fan wheel, catch basin and locking ring are checked to make sure they are firmly in position. The classifier lid is secured in the locked position, and the motor started. When the classifier has achieved maximum angular velocity, generally after 20 seconds,

the vibrator is switched on and set at the position indicated by the mark on the outer casing, which corresponds to a high setting. When using Spacer No. 18, which separates at ~1 μm, it is necessary to have the vibrator in the high position to aid the flow of feed material. Generally, by setting the vibrator at the indicated position, the flow rate will be 1.0 to 1.5 g/min. A trial run should be conducted to establish the flow rate and the vibrator setting increased or decreased accordingly.

When the sample has passed through the classifier, the motor and vibrator are switched off; the classifier can be stopped by applying the brake for brief periods. The locking ring is detached and the rotor assembly removed. Material which is finer in size than the spacer setting will collect around the periphery of the inner rotor casing and material coarser in size than the spacer will be collected in the catch basin or immediately above it, hung up on the inner portion of the fan wheel. The oversize in the catch basin and on the underside of the fan wheel are brushed off, weighed and the weight of undersize material calculated by difference. If the undersize portion is required for chemical or mineralogical analysis, it can be brushed down from the inner rotor casing.

The rotor assembly is reassembled and locked in position with the locking ring. The oversize material is then repassed through the classifier a second time to allow any remaining trapped undersize material to be separated. After a second pass through the classifier the rotor assembly is again removed, the oversize portion in the catch basin reweighed and the weight of any further reclassified undersize calculated by difference.

The No. 18 spacer is removed, replaced with the next spacer, No. 17 and the procedure repeated. Successive spacers in the series are used up to No. 4. The last position without any spacer, with the throttle nut turned to the lowest position, is spacer No. 0.

As the fine material is progressively removed with successive spacers, the remaining material flows more freely, and the vibrator setting should be lowered to maintain the same flow rate. If the high setting is maintained the material will flow through too quickly and will be insufficiently classified. In fact, for the final two spacers, No. 8 and 4, it is not necessary to use the vibrator as there is sufficient vibration from the motor turning the classifier.

SCOPE OF STUDY

When a sample has been passed through the complete range of spacers, several weight fractions are obtained which can be correlated to either an actual mode size in microns or to terminal velocity. The mode size of each fraction can be easily determined knowing the specific gravity of the mineral and the terminal velocity for each spacer, by the use of a calibration chart which relates mode size to terminal velocity for specific gravities ranging from 1 to 20.

The classifier was originally calibrated using as a standard, fly ash[2] of specific gravity 2.5. Theoretical terminal velocities based on the mode sizes of each spacer fraction of fly ash are presented in Table 1. Using these values of terminal velocity, theoretical mode sizes for barite and silica were calculated and are reported also in Table 1.

The object of the present study, therefore, was to compare measured mode sizes to the theoretical mode sizes of selected non-metallic minerals.

TESTWORK PROCEDURE

The Bahco air classifier was calibrated using -50 μm barite and -50 μm silica flour. These minerals were chosen because there is a significant difference in specific gravity.

A predetermined weight of each mineral was classified in the manner outlined, using each spacer and the fraction from each spacer sized using a Sedigraph in conjunction with an Apple computer. The computer print-out presented data by two methods, a tabulation of size versus rate of change of % weight and a graphical presentation of the same relationship. An example of computed size determinations is presented in the appendix. The point of maximum rate of change is taken to be the mean (mode) size of the fraction. This procedure was repeated for each of the eight spacer fractions. A tabulation of spacer mode size versus percent weight in each spacer fraction for barite is reported in Table 2. A similar tabulation of results for silica flour is reported in Table 3.

RESULTS

The comparison between the measured and the theoretical relationship of size versus terminal velocity is represented graphically as Fig. 2 for barite and Fig. 3 for silica. In Fig. 2 the curve for the measured mode size versus terminal velocity for barite is reasonably close to the theoretical relationship. There is some divergence between 3 μm to 6 μm but above 6 μm and below 3 μm the divergence is less. In Fig. 3 there is less divergence than in Fig. 2 between the measured curve and the theoretical straight line relationship of size versus terminal velocity.

REFERENCES

1. Graham, A.L. and Hanna, T.H. "The Micro-particle classifier"; Ceramic Age; September 1962.

2. Todd, W.F., Hagan, J.E. and Spaite, P.W. "Test dust preparation and evaluation"; Robert Á. Taft Sanitary Engineering Center; U.S. Public Health Service, Cincinnati; 1963.

Table 1. Theoretical mode sizes for barite and silica based on fly ash (S.G. 2.5) calibration

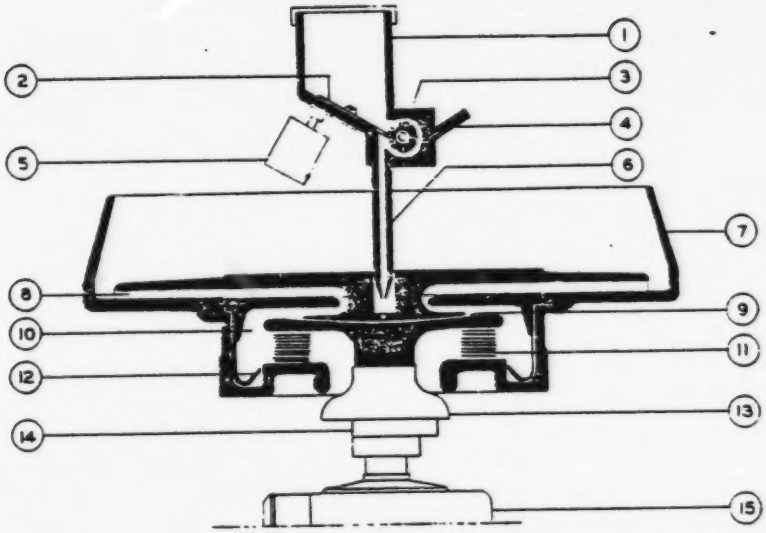
Spacer No.	Mode Size (fly ash)	Terminal Velocity (based on fly ash)	Theoretical mode size	
			Barite	Silica
	μm	mm/min	μm	μm
-18	1.3	7.6	1.0	1.3
-17+18	2.1	19.6	1.6	2.0
-16+17	4.2	78.7	3.2	4.0
-14+16	7.9	271.8	5.8	7.6
-12+14	12.4	673.1	9.2	11.8
-8 +12	21.8	2,082.8	16.0	21.0
-4 + 8	29.0	3,708.4	21.4	27.8
-0 + 4	32.5	4,673.6	24.0	31.0

Table 2. Classification of -50 µm barite

Spacer No.	Mode Size µm	% Weight Direct	Cumulative % wt finer
-18	1.4	6.7	6.7
-17+18	3.3	13.5	20.2
-16+17	6.4	14.8	35.0
-14+16	8.6	7.4	42.4
-12+14	11.3	17.5	59.9
-8 +12	17.9	12.9	72.8
-4 + 8	22.4	4.9	77.7
-0 + 4	23.1	3.2	80.9
+ 0	-	19.1	-
TOTAL		100.0	

Table 3. Classification of -50 µm silica flour

Spacer No.	Mode Size µm	% Weight Direct	Cumulative % wt finer
-18	1.5	7.7	7.7
-17+18	3.8	13.8	21.5
-16+17	7.0	12.6	34.1
-14+16	11.4	11.3	45.4
-12+14	16.9	18.1	63.5
-8 +12	24.5	12.3	75.8
-4 + 8	26.8	5.1	80.9
-0 + 4	34.1	19.1	-
TOTAL		100.0	



—1. hopper, 2. spring plate, 3. brush, 4. orifice tube, 5. vibrator, 6. feed nozzle, 7. rotor casting, 8. fan wheel vanes. 9. rotary duct opening, 10. sifting chamber, 11. symmetrical discs, 12. catch basin, 13. throttle nut, 14. throttle spacer, 15. motor.

Fig. 1. Cross-sectional view of the Bahco air classifier.

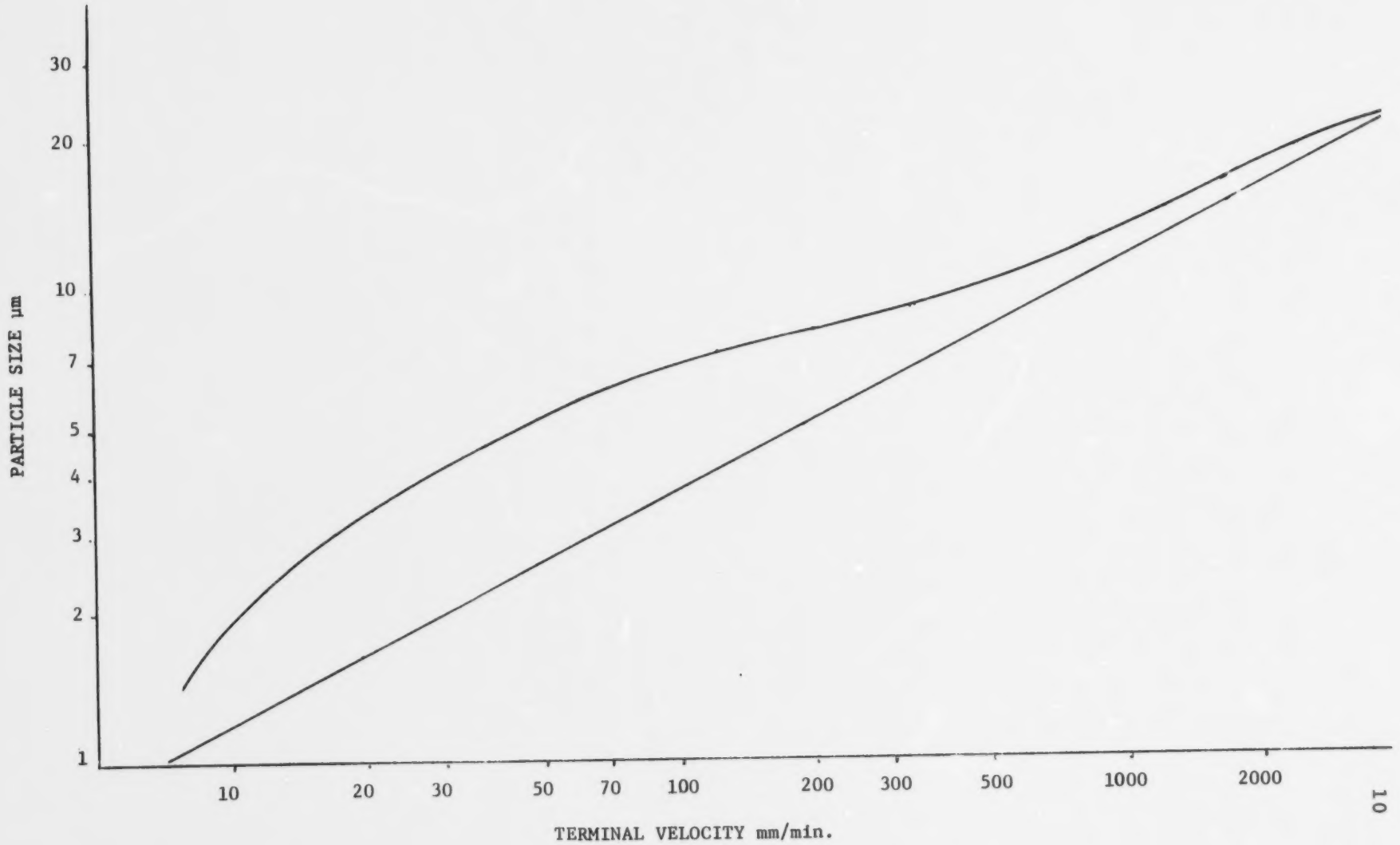


Fig. 2. Particle size versus terminal velocity for barite.

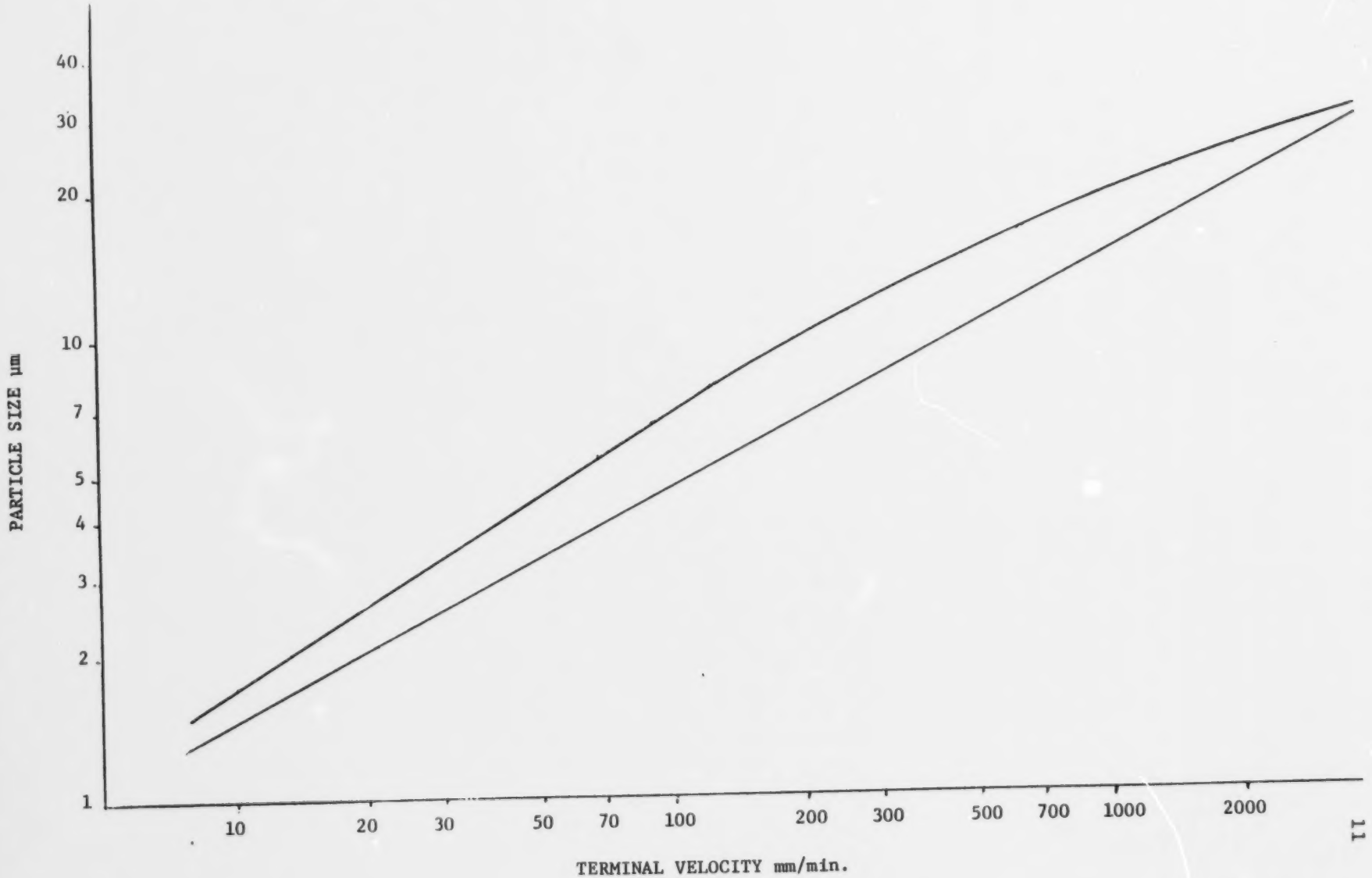


Fig. 3. Particle size versus terminal velocity for silica flour.